

SIR GEORGE WILLIAMS UNIVERSITY

PROPOSED PROGRAM

FOR THE

MASTER'S DEGREE IN COMPUTER SCIENCE

Submitted by the Faculty of Engineering
to the Board of Graduate Studies.

October 1968

MASTER'S DEGREE PROGRAM IN COMPUTER SCIENCE

Introduction:

In the interest of providing justification for the proposed program and from this indicating the areas in which Sir George can fulfill the computing needs in the community, a brief introduction seems appropriate.

The present status of the computing industry is such that the availability of computing hardware has outstripped the training of competent professional users⁽¹⁾. Many surveys^{(2), (3), (10)} of industry and government have indicated a severe shortage at present and indications are that this shortage will be greatly aggravated in the near future. The chief impediment to growth in applications is in the area of systems development - that is in the development of areas which are presently well understood from the technological point of view but any inroads to be made through computer usage are limited due to the fact that the professionals in this area have little or no background in computing. If the shortage persists at this level, retraining of personnel at lower echelons will be retarded and the shortage will escalate. On the other hand, by providing persons who are already competent in a profession such as engineering, mathematics, science or business with a computing background, the present and future shortages of personnel can be alleviated to some extent.

A second area in which there is a severe shortage is in secondary and post secondary school education. It is becoming increasingly evident that some form of computer teaching and training is necessary in the secondary schools⁽³⁾ and the CEGEP's as well as increasing Computer Science teaching at the undergraduate level in universities. Therefore, it is necessary that a second aspect of any graduate program in Computer Science must be to provide a means whereby teachers may improve their knowledge of this field and where graduate students may also have access to a curriculum which will provide the background necessary for them to proceed to the doctoral level with the intention of becoming faculty members.

From the shortcomings presently in evidence in the computing industry, a program such as that outlined in this brief, which leads to a Master's Degree in Computer Science will certainly contribute to a solution of the problem.

Objectives

Broadly speaking, a Master's Degree program in Computer Science may have any or all of the following three objectives: (1) preparation for further study to the doctoral level by developing a student's intellectual capacities; (2) development of professional competence in problem solving related to present and future computing applications; (3) providing a background in computing for persons who will become involved in technical administrative positions and business or educational administration⁽⁴⁾. The first two objectives may be achieved in a Master Degree program as proposed by varying the areas of concentration. The third objective may be accomplished by providing graduate students in other disciplines with access to specific courses in Computer Science. The details of a Master's Degree program to achieve these goals is provided in the accompanying formal proposal.

I. Beginning of Program

The Faculty of Engineering proposes to offer its Master's Degree program in Computer Science in the academic year 1970-71.

II. Curriculum

(a) Intent

The Master's program in Computer Science is intended to provide a background in computing to persons who have followed an undergraduate program in computer science, mathematics, science, engineering, or a quantitative business administration curriculum. Graduates from the program will be expected to re-enter their profession or continue to a Ph.D. degree.

(b) Entrance Requirements

Candidates for the degree will be expected to have an honours degree or its equivalent in any of computer science, mathematics, science, engineering or business administration. The graduate studies committee of the Faculty of Engineering will determine the acceptability of an applicant and may require that certain undergraduate courses be taken to fill any deficiencies.

(c) Residence Requirements

A minimum of one academic year for full-time students and two or three years for part-time students depending on the degree of their involvement outside the program.

(d) Degree Requirements

i. Courses - a candidate for the degree will normally be required to take between six and eight half courses or their equivalent; four of these must be selected from the graduate courses offered in Computer Science; of the remaining courses at least two must be selected from graduate programs in other disciplines. In special circumstances, senior undergraduate courses may be acceptable in the last category. (A list of course offerings in Computer Science is given below and is based on three rather comprehensive reports produced by a number of groups in the past few years^{(5), (6), (7)}).

ii. Thesis - each candidate for a degree must submit a research paper or project report on work carried out under the supervision of a member of the Computer Science faculty. The nature of the work will be determined in individual cases on the basis of the candidates interest and the projects available. These projects may be associated with research being conducted in other disciplines in which the Computer Science faculty and/or the Computer Center are actively involved and administrative projects within the University⁽⁴⁾.

Computer Science Graduate Courses

Computer Science 610. Introduction to Computers and Computing.

(Course for students with little or no computing background). The basic concepts of stored program computers, the algorithmic method of problem solution. Machine and assembly languages. Number representation. Number systems. Applications of a high level language (FORTRAN) in numerical methods. Non-numerical applications. Discussion of other languages. Some of the underlying concepts of the theory of automata.

Four hours lectures per week.

Two hours tutorials. One term.

Computer Science 620. Numerical Analysis I.*

An introduction to numerical analysis. Errors, evaluation of function, roots of polynomials, solution of equations, numerical differentiation and integration, application of specific algorithms.

Two hours lectures per week.

Two hours tutorials. One term.

* Numerical Analysis I and II may be given by the Mathematics Department.

Computer Science 621. Numerical Analysis II.

Matrix methods in solving systems of equations: evaluation of determinants, eigenvalues, eigenvectors. Application to boundary value problems in ordinary differential equations. Numerical solution of partial differential equations.

Application of specific algorithms.

Two hours lectures per week.

Two hours tutorials. One term.

Computer Science 630. Data Structures

Basic concepts of data, storage, listing, etc. Storage systems and structures. Formal specification of data structures, data structures in programming languages and other large scale systems.

Computer Science 631. Programming Languages.

Formal definition of languages. Syntax. Semantics. Global properties of algorithmic languages. List processing, data description and simulation languages.

Computer Science 632. Computer Organization.

Discussion of basic components, logical design. Storage, accessing, input/output. Discussion of specific features, multiprogramming, multiprocessing and real time systems.

Computer Science 633. Systems Programming.

Management of computer systems from the operational point of view. Overall structure, traffic control, teleprocessing.

Computer Science 650. Large Scale Information Systems.

Organization and optimization of information systems using simulation techniques. Communication problems among individuals involved in systems development.

Computer Science 660. Sequential Machines.

Definition and representation of Finite State Automata. Equivalence. Analysis and synthesis of machines. Decision problems.

Computer Science 661. Introduction to Automata Theory.

Finite State Machines, Turing machines, universal machines. Computability and algorithms. Recursive functions.

(e) Timetable

It is anticipated that as many of the courses in the program as possible will be scheduled in the late afternoon and early evening in order to accommodate both full-time and part-time students.

III. Faculty

Computer Science as an academic discipline is relatively new and therefore precludes the possibility of many faculty members being qualified in this specific area. The situation elsewhere^{(2), (5)} and at Sir George is such that there has not been any past to Computer Science, the people involved in such programs have been drawn from other disciplines, the only common denominator being a consuming interest in this new discipline. By far the best sources of Computer Science faculty have been mathematics, science and engineering. A distinctive feature of the proposed program in regard to faculty requirements is the fact that there is not a corresponding undergraduate program at Sir George. The current courses in Computer Science are given as service courses and involve people who are engaged primarily in the Computer Center.

With these two points in mind, the nucleus of the faculty for the Computer Science program will be gleaned from existing departments both by actual transfers and by establishing split-appointments. As indicated below, additional faculty members have been requested for 1969-70 in order to meet the ever-increasing demand for undergraduate courses and to reduce the number of part-time lecturers in the undergraduate courses.

Curriculum vitae of the faculty members appear in Appendix I. Existing faculty members consist of one associate professor, one assistant professor in engineering (the Director of the Computer Center), one part-time lecturer who will become an assistant professor while maintaining his position in the Computer Center and one assistant professor in Electrical Engineering who will share an appointment between that department and Computer Science. In addition, the five-year plan includes a requirement for six additional faculty members, four in 1969-70 (as reflected in budget submission) and two in 1970-71. These numbers were specified in the light of existing undergraduate needs and of the implementation of the present proposal. Should the four appointments be authorized for 1969-70, in order to adequately meet our undergraduate need, then the incremental faculty requirement for the proposed program will be two full-time faculty members.

The number of graduate students that can be accommodated in the first year of the program will be approximately thirty-five full-time equivalents, the limit being prescribed by the availability of faculty to supervise the research portion of the program. The possibility of students carrying out a project outside the University following the pattern in the M.Eng. program will broaden the base of the research activities.

IV. Library

The library collection in Computer Science is adequate, however, some minor additions are required in specialized areas such as information retrieval and systems. A survey of our present holdings has been initiated and this report should be available by November 10, 1968.

In respect of the library, it is hoped that one or more of the graduate projects conducted within the program will contribute to current developments in information retrieval and library management in general.

V. Plant and Equipment

The prime equipment and plant required for a Master's program in Computer Science is a computer. In this regard, the computer in the Computer Center at Sir George Williams University provides an excellent tool. The Control Data 3300 computer is a medium-large scale computer of a size and type very suitable for experimental work and research in addition to ongoing productivity. Some of its features including the latest in computer time sharing operations and sophisticated operating systems enable the student to work in almost any area of Computer Science research. In addition to the central computer facility, a hybrid facility is being built up within the faculty of Engineering and will be available for additional research and development projects in Computer Science.

While it must be expected that Computer Science students will place a significantly increased load on this facility, it is expected that this will be offset by the assistance of and the new techniques developed by these students which will be of use to the Center. The Center is aware of the need to advance knowledge in this area and keep up with developments in the field. To this end, a number of projects at an advanced level are already underway through the initiative of the Computer Center.

As such, the addition of thirty-five full-time equivalent graduate students, while it will add to the Computer Center load, will not cause a significant increase over the normal expansion to be expected by an academic Computer Center.

VI. Students

The need for a Computer Science graduate degree program in this geographical area can be established in two ways: (1) by considering the anticipated requirements for professional computer scientists and (2) by looking at the field of computing as it exists. The current situation is indicated by the following quotation⁽⁹⁾, "Computer employment agents and management consultants estimate the shortage of qualified computer personnel between 1500 and 4000" in Canada. The past seven years indicate that computer personnel requirements double every two years⁽¹⁰⁾. The universities cannot produce all of these people so that most of them will have to be trained on the job. The University's function is to provide the leadership necessary in Computer Science so that this on-the-job training may be accomplished. From the point of view of the existing situation, there are many indications that present day facilities are not being exploited to the full due to the shortage of people with a sufficiently high degree of knowledge in Computer Science and related fields. To quote Prof. J. W. Graham, Past President of Canadian Information Processing Society, " applications for computers are going ahead faster than people can be developed to implement them. It will take another ten years before there is a shake out".⁽⁹⁾

The relevance of the proposed program to present and future needs is not only based on the number of people

required. There are any number of areas where the development of new systems will provide additional means for accomplishing our goals in the fields of research and development, dissemination of scientific and technical information and economic development. Developments in these areas through the use of computing methods will help to reduce our chronic need for certain kinds of technicians.

VII. Additional Resources Other Than Faculty

The additional resources required are classified as "negative", that is, supplied by the University and "positive", additional resources which will accrue to the University through the proposed program.

Resources to be provided by the University include such things as offices, secretarial assistance, office supplies, travel funds, and other similar costs.

Additional resources include such things as support for research through the National Research Council in the following ways:

- 1) Personal grants to faculty members actively involved in research.

- 2) Computing grant to the Computer Center which is in proportion to the total of personal grants to University faculty members.

- 3) The Principal's grant which is related to the total of other operating grants to the University.

A second way in which additional resources may be made available to the University is through direct industrial support of certain projects. This is a difficult sum to speculate upon, however, the need for systems development in the field of computing is such that it is certain that some support will be forthcoming in this area.

VIII. Future Development

Future development of the program will be concerned with increasing the number of areas of specialization as the faculty in computer science and in other faculties grows. A five year plan outlining the development of Computer Science in general at Sir George is available and is listed in the bibliography.

BIBLIOGRAPHY

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- (3) Forsythe, G. E.

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- (4) Rourke, F. E. and Brooks, G. E.

"The Managerial Revolution in Higher Education". Baltimore, John Hopkins University Press, 1966.

- (5) Curriculum 68

Recommendation for Academic Programs in Computer Science - A report of the ACM Curriculum Committee on Computer Science. Communications of the Association for Computing Machinery. Vol. 11/Number3/March 1968.

(6) Computers in Higher Education

Presidents Advisory Committee. The White House.
Washington, D.C. February 1967. 79 pp.

(7) Computer Sciences in Electrical Engineering

An interim report of the COSINE Committee of the
Commission on Electrical Engineering Education, 1501
New Hampshire Avenue, N.W., Washington, D.C. Sept. 1967.
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(8) Computer Science Five Year Plan

Faculty of Engineering, Sir George Williams
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(9) Financial Post

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(10) Rapport du Comité Consultatif de la Technologie de
L'Information au Misistre de L'Education. 1968

APPENDIX I

CURRICULUM VITAE

CURRICULUM VITA

George K. FLEMING - Associate Professor of Computer Science

Born: April 13, 1933 - Humboldt, Saskatchewan

Degrees and Diplomas:

- 1957 - Engineering Diploma - St. Francis Xavier University
- 1957 - Bachelor of Mechanical Engineering - Nova Scotia
Technical College
- 1960 - Master of Applied Science - University of British
Columbia
- 1967 - Doctor of Philosophy - University of Waterloo

Graduate Teaching Experience:

- 1965-1968 - Associate Professor at Universite de Sherbrooke
 - Taught graduate students and supervised Master Thesis. Examiner for Master Thesis.
 - Established programs in computing for both graduate and undergraduate students.
 - Responsible for selecting computing equipment and establishing computing center. Director of computing center for one year.

Professional Associations:

1. Canadian Information Processing Society
2. Engineering Institute of Canada
3. Corporation of Engineers of Quebec
4. Member, American Society of Mechanical Engineers

Publications to date are all connected with Applied Mechanics problems, however, current research is in connection with computer applications in Control System design and optimization.

SIR GEORGE WILLIAMS UNIVERSITY

COMPUTER CENTER

CURRICULUM VITA

Graham MARTIN - Assistant Professor of Electrical Engineering
- Director of the Computer Center

Born: May 5, 1939 - Liverpool, England

Education:

Bachelor of Science, Electrical Engineering, University of
New Brunswick - 1961

Master of Science, Electrical Engineering, University of
New Brunswick - 1962

Professional Experience:

Lecturer in Electrical Engineering, Sept. 1962 to Sept. 1964

Assistant Professor of Electrical Engineering, 1964 to present

Responsible for the development of an undergraduate
Electrical Engineering program up to 1965.

Appointed full-time director of the Computer Center, Sept. 1965
to present

Responsible for the University Computer Center including
all facets of computation and data processing. Supervise the
development of research programs for a number of faculty research
problems. Responsible for the development of undergraduate
teaching program in Computer Science.

Courses Taught:

Undergraduate Level

Introductory Electrical Engineering
Mechanical Drawing
Electronic Circuit Theory

Courses Taught: (cont'd)

Introductory Computer Programming
Advanced Computer Programming
Computer Organization and Software
Computers and Control Systems
Logical Design and Switching Theory

Papers and Conferences:

1. Development of Generalized "N" Node Program for Topological Analysis of Electrical Networks - B.Sc. Thesis, University Of New Brunswick - 1961
2. Development, design, and construction of Analog Hybrid Conversion Equipment and Real Time Computer Processing - Master of Science Thesis in Electrical Engineering - University of New Brunswick - Sept. 1962.
3. Participated as joint author of several papers in related research fields since appointment to the Computer Center.

Research and Development Interests:

1. Development of general purpose problem solving software for the solution of Engineering problems.
2. Improving the man-machine interface and computing communications.
3. Heuristic programming.

SIR GEORGE WILLIAMS UNIVERSITY

Computer Center

CURRICULUM VITA

David W. PENNER - Manager of Operations - Computer Center

Born: September 19, 1942 - Toronto, Ontario

Education:

Honours Math and Physics, McGill University, 1959-60, no degree.

Bachelor of Science, Honours Physics, University of Alberta, 1960-1963.

Master of Science, Physics, University of Alberta, 1963-64.

Working toward Ph.D., University of Alberta, 1964-65, no degree.

Professional Experience:

Applications Analyst, Control Data Canada Ltd., May 1965 to July 1966

Programmer Analyst, S.M.A. (Societe Mathematique Appliquee), Aug. 1966 - May 1967

Manager of Operations, Sir George Williams University, June 1967 to present

Courses Taught:

Undergraduate:

Engineering 214 (Computer Programming)

Engineering 371 (Numerical Analysis and Computer Programming)

Computer Science 471 (Numerical Analysis and Computer Programming)

Computer Science 410 (Advanced Computer Programming)

Papers and Conferences:

1. Master's Thesis in Low Temperature Physics - Fall 1964.
2. SGWU PERT Program (SWAP Conference, Fall 1967).

Research and Development:

1. Low Temperature Physics - 1963-65
2. PERT (Programme Evaluation and Review Technique) - 1967-68
3. Theory of Compilers and Time Sharing in Computers - 1968